HIGH-DENSITY PLASMA SOURCE FOR LARGE-AREA CHEMICAL VAPOR DEPOSITION OF DIAMOND FILMS

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MONTHLY REPORT

1. Introduction

During this program Science Research Laboratory (SRL) and the Plasma Processing Group in the Department of Chemical Engineering at MIT are developing a large-area, directed plasma/atomic beam source for diamond deposition. The plasma source is based on an inductively-driven plasma accelerator that efficiently produces a high density (10^{14}-10^{17} cm^{-3}) plasma over an area of 0.1-1 m^2. The goal of this effort is to experimentally demonstrate the technical feasibility of employing the plasma source for high-throughput diamond deposition, through characterization of plasma parameters and preliminary diamond deposition experiments. A reactor design study will also be completed during Phase I, leading to an engineering design of a large-area plasma reactor for Phase II implementation. The period of performance is from 30 September 1994 to 29 May 1995.

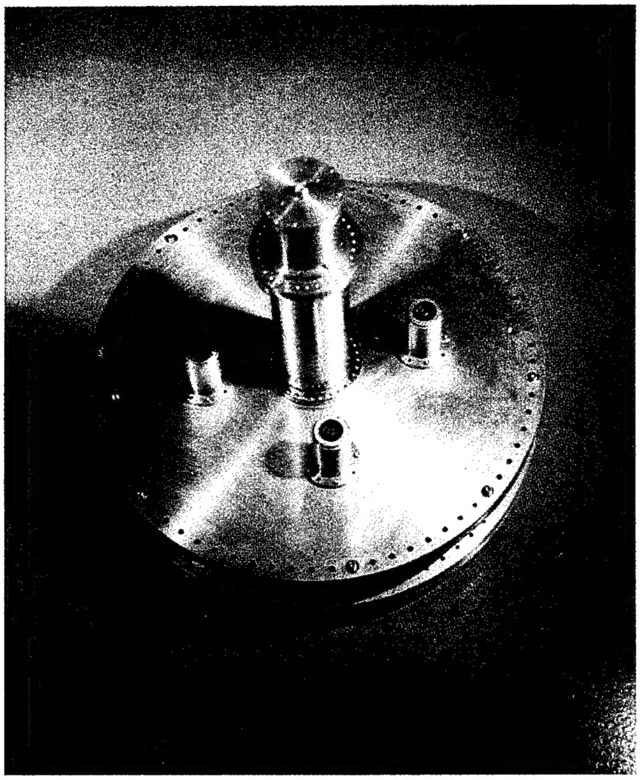
2. February Progress

The preliminary activity during February was the final assembly and test of the high-repetition-rate, all-solid-state pulsed driver that will power the plasma beam reactor. We are pleased to report that the 100-joule-per-pulse, 100-kW average power driver system is completed and is performing satisfactorily. The driver consists of three 35 joule low voltage (1 kV peak) pulse forming units, a charger, a high voltage (25 kV peak) pulse compressor, and an electronic control unit that generates proper timing and triggering pulses. Photographs of these modules are shown in Figure 1.

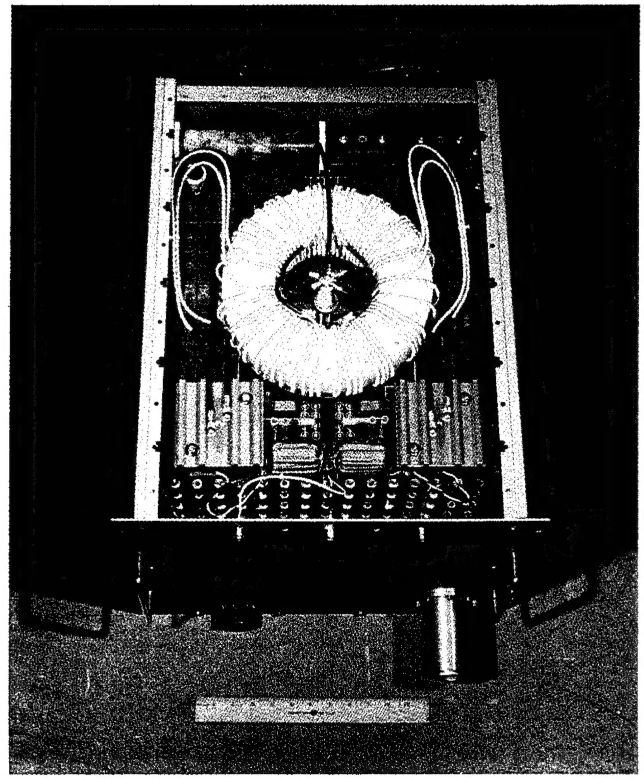
Fabrication of the heated molybdenum wafer substrate for Phase I diamond deposition experiments was underway at MIT. The reactor backplate design has been submitted for fabrication. Tests of the optical emission spectrometer (OES) and thermal couple hydrogen atom detector were made on an existing microwave plasma reactor at MIT. Both of these analytical devices will be incorporated into the backplate of the reactor under construction at SRL. The measurements with the microwave plasma serve as calibration for the large scale experiments.

As discussed in the original research proposal and the January Monthly Report, the inductively-driven, large-area plasma beam reactor to be investigated in this Phase I STTR program is based

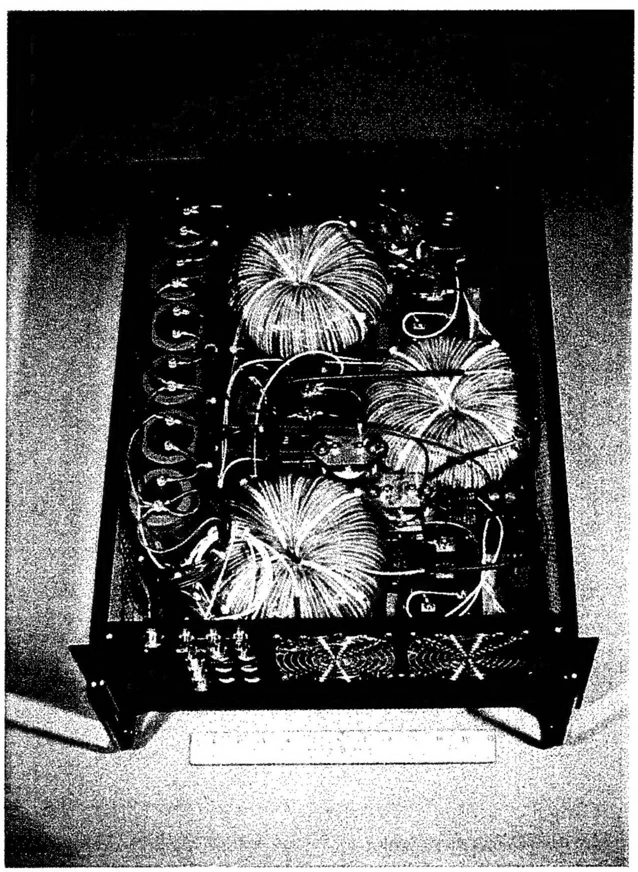
High Voltage Compressor Head



Commutator Module



Command Resonance Charger



Control Module

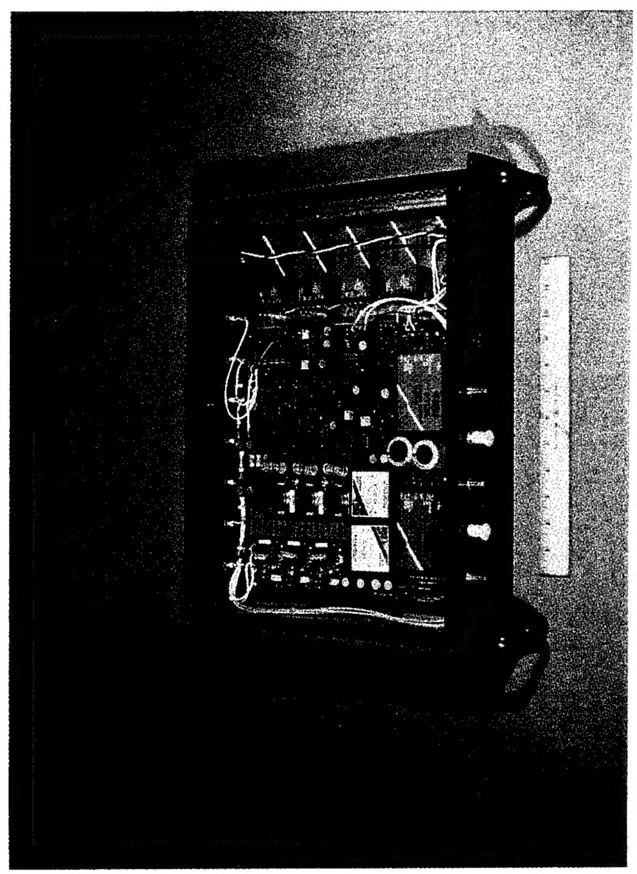


Figure 1: Photographs of all-solid-state pulsed driver components.

on a high-power plasma accelerator concept that was developed under a BMDO SBIR for electric propulsion applications. Due to funding delay in that program, the Phase II BMDO program started in August 1994 instead of August 1993 as originally planned. SRL accelerated the BMDO program and the fabrication of the plasma accelerator system has proceeded at twice the speed as initially planned. With the completion of the all-solid-state pulsed driver, we expect the initial operation of the plasma accelerator by the middle of March 1995.